THIS OPINION WAS NOT WRITTEN FOR PUBLICATION

The opinion in support of the decision being entered today (1) was not written for publication in a law journal and (2) is not binding precedent of the Board.

Paper No. 26

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte KEIRO KOMATSU

Appeal No. 1997-4033
Application No. 08/589,584[1]

ON BRIEF

Before MARTIN, BARRETT, and FLEMING, Administrative Patent Judges.

MARTIN, Administrative Patent Judge.

DECISION ON APPEAL

This is an appeal under 35 U.S.C. § 134 from the examiner's final rejection of claims 22-26, all of the pending

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[1] Application for patent filed January 22, 1996.

claims, under 35 U.S.C. § 103.[2] We reverse and enter a new ground of rejection under 35 U.S.C. § 112.

The invention

The invention is an improved Mach-Zehnder optical modulator, which is depicted in appellant's Figure 1. A single input is branched by a Y-shaped branching structure in the first passive region 121, whereafter the light is conveyed along two parallel straight phase modulator sections in the active region 122, which sections are rejoined by a second Y-shaped branching structure in the second passive region 123 (Brief at 2). Application of a driving voltage to one or both electrodes 110a and 110b overlying the parallel modulator sections in the active region allows controlled variation of the refractive index of the waveguide material (id.). The Brief further explains (at 2):

> The present invention seeks to achieve the conflicting objects of minimizing the driving voltage which must be applied to the electrodes in the active region, while also minimizing light propagation loss from the wave-guide (see, for example, page 6, lines 10-15 [of the specification]). That is, the necessary driving

[2] The new ground of rejection of claims 22-26 under 35 U.S.C. § 112 entered in the Answer (paper No. 23) was withdrawn in paper No. 25, mailed August 20, 1997.

> voltage for the wave-guide is reduced when the band gap wavelength of the wave-guide material approaches the wavelength of the incident light; however, in that condition, propagation loss from the wave-guide is high (see page 4, lines 8-17 of the specification).

The Brief (at 2-3) contains the following description of the structure of the invention, which correctly states that a wider mask stripe produces a higher band gap wavelength but appears to incorrectly state that the wider mask stripe and higher band gap wavelength are associated with a <u>thinner</u> MQW structure:

> The present invention achieves [the above-noted] previously conflicting aims by forming the optical wave-guide as a multiple quantum well (MQW) structure having <u>controlled thickness</u> in the central active region relative to the terminal passive regions. In particular, the MQW structure is relatively thinner in the central active region and relatively thicker in the terminal passive regions, such that, correspondingly, the band gap wavelength of the optical wave-guide is relatively higher in the active region and relatively lower in the passive regions. This allows the band gap wavelength in the active region to be set to a value desirably close to that of the incident light which will pass through the wave-guide, while keeping the band gap wavelength in the passive regions at a desirably low level to minimize wave-guide loss. The controlled variation in the thickness of the optical wave-guide structure is achieved by forming the MQW layers by a technique termed Metal Organic Vapor Phase Epitaxy (MOVPE), using a mask stripe pattern as shown for example in present Fig. 3. That is, the relatively wider mask stripes 201 in active

> region 122 result in the formation of a thinner MQW structure in the exposed spaces 202 of active region 122; whereas the relatively narrower mask stripes 201 in passive regions 121 and 123 result in the formation of relatively thicker MQW structure in the spaces 202 of passive regions 121 and 123.

Appellant’s specification as filed has very little to say about the thickness of the MQW structure.[3] It simply states (at 16, lines 7-8) that "[t]he thickness of the quantum well is proportional to the width of the mask pattern 201," which suggests direct rather than inverse proportionality. Moreover, a directly proportional relationship is described in the Sasaki et al. reference (Sasaki), which explains that

> [s]electively grown layer thickness depends on mask pattern, because, under certain growth conditions, most of the source species over the masked region do not deposit on the mask region and they diffuse laterally to the growth region. <u>Layer thickness increases with the mask stripe width</u>. [Emphasis added.] [Sasaki at 374, 2d col., lines 9-15.]

Consistent with this statement, Sasaki discloses using mask stripe widths of 3 Fm and 10 Fm to form well thicknesses of 5.2 nm and 6.6 nm, respectively (Sasaki at 375, 1st col.,

[3] However, the specification as amended at page 11, line 3, calls for the MQW structure to be thicker in the passive regions than it is in the active region. <u>See</u> Preliminary Amendment filed January 22, 1996 (paper No. 13).

lines 21-27). See also Ishizaka U.S. Patent 5,757,985 (copy attached), which at column 5, lines 13-17 describes a Mach-Zehnder modulator having a thicker MQW structure in the modulator region than in other regions.[4] Consequently, claim 22, which together with dependent claims 23-26 was added by the above-mentioned preliminary amendment, is believed to be misdescriptive of appellant's disclosed invention by reciting a thinner MQW structure in the active region than in the passive regions. For the same reasons, the above-noted amendment to the specification is also believed to be incorrect.

However, claim 22 is accurate to the extent it specifies that using a small mask stripe width in the passive regions results in a "band gap wavelength smaller than that provided on said active region." This is consistent with Sasaki's Figure 4, which shows that 10 Fm-wide mask stripes result in a

[4] Ishizaka, like the application on appeal, is assigned to NEC Corporation.

higher peak band gap wavelength (1550 nm) than do 4 Fm-wide mask stripes (1500 nm).[5]

Entry of a new ground of rejection under 35 U.S.C. § 112

Because claim 22, reproduced below, is incorrect to specify that "said multiple quantum well optical wave-guide layer provided on said first and second passive regions has a thickness larger than that provided on said active region," we are hereby entering a new ground of rejection of claims 22-26 under 35 U.S.C. § 112, first paragraph, as lacking written description support in the original disclosure, which as filed did not disclose making the MQW structure thinner in the active region than in the passive regions. Nevertheless, in the interest of completeness we will also address the merits of the examiner's § 103 rejection.

The claims

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[5] Sasaki's Figure 4 also shows what appear to half-amplitude widths of 58.9 meV and 58.8 meV for the 4 Fm and 10 Fm characteristic curves, respectively. These values may be the basis for Sasaki's statement that "bandgap energy of selectively grown MQW structure decreases with the increase of layer thickness of wells" (Sasaki at 374, 2d col., lines 15-17).

Claim 22, the only independent claim, reads as follows:

22. A Mach-Zehnder optical modulator having first and second passive regions and an active region between said first and second passive regions, said Mach-Zehnder optical modulator comprising:

a semiconductor substrate extending over said first and second passive regions and said active region;

a bottom electrode extending on an entire part of a bottom surface of said semiconductor substrate;

a first cladding layer extending on an entire part of a top surface of said semiconductor substrate;

a ridge-shaped optical wave-guide having: a Y-shaped branching passive wave-guide section on said first passive regions [sic, region]; a Y-coupling passive wave-guide section on said second passive regions [sic, region]; and two parallel straight phase modulator sections on said active region; wherein said ridge-shaped optical wave-guide comprises:

a buffer layer provided on said first cladding layer;

a multiple quantum well optical wave-guide layer provided on said buffer layer, said multiple quantum well optical wave-guide layer being grown by a metal organic vapor phase epitaxy using dielectric stripe masks having a large width in said active region and a small width in said first and second passive regions so that said multiple quantum well optical wave-guide layer provided on said first and second passive regions has a thickness larger than that provided on said active region and so that said multiple quantum well optical wave-guide layer provided on said first and second passive regions has a band gap wavelength smaller than that provided on said active region;

a second cladding layer provided on said multiple quantum well optical wave-guide layer;

a third cladding layer covering a top surface of said second cladding layer and sloped side walls of laminations of said buffer layer, multiple quantum well optical wave-guide layer, and second cladding layer; and

a cap layer formed on a top surface of said third cladding layer;

a dielectric film covering at least an entire surface of said ridge-shaped optical wave-guide; and

two top electrodes extending over an entire part of said two parallel straight phase modulator sections.

The references and rejection

The examiner relies on the following references:

Sasaki et al. (Sasaki), Novel Structure Photonic Devices Using Selective MOVPE Growth, 33 NEC Research & Development 372-82 (1992).

Rolland et al. (Rolland), 10 Gbits/s, 1.56*u*m MULTIQUANTUM WELL InP/InGaAsP MACH-ZEHNDER OPTICAL MODULATOR, 29 Electronics Letters 471-72 (1993).

Claims 22-26 stand rejected under 35 U.S.C. § 103 as unpatentable for obviousness over Rolland and Sasaki.

The merits of the examiner's 35 U.S.C. § 103 rejection

The 35 U.S.C. § 103 rejection is unsustainable even assuming the claims are accurate to call for the MQW structure to be thinner in the active region than in the passive regions.

Rolland discloses a Mach-Zehnder modulator which includes a "singlemode" section that is 2 Fm wide followed by a "triple-moded" section that is 4 Fm wide, which branches into a pair of S-rib waveguides 2 Fm wide and 3 Fm deep, which are rejoined by another 4 Fm branching section, which is followed by a final 2 Fm wide section (Rolland at 371, 2d col.). Rolland does not explain how much of the 3 Fm depth of the rib sections is occupied by the MQW structure. Nor does Rolland indicate that the MQW structure has different thicknesses in the active and passive sections.

As already noted, Sasaki explains that MQW thickness and band gap wavelength are a function of the width of the mask stripes used to form the MQW layers. Sasaki explains (at 372-73) that this bandgap energy control technique can be used to form smooth junctions between active and passive waveguide layers in various types of monolithically integrated photonic devices, such as (1) a DFB-LD (Distributed Feedback Laser Diode) monolithically integrated with an optical modulator and (2) a three-section tunable DBR (Distributed Bragg Reflector)-

LD, which is attractive for Wavelength Division Multiplex (WDM) systems and coherent optical transmission systems. Sasaki also explains that these devices include portions having different band gap energies: "In these devices, the active layer and the passive waveguide layer, where bandgap energy of each layer is different, should be smoothly joined along the waveguide direction" (Sasaki at 373, 2d col.). In the DFB-LD/modulator (Fig. 8), the mask stripe width was 10 Fm for the DFB-LD region and 4 Fm for the modulator region (Sasaki at 377, 2d col.). In the three-section tunable DBR-LD (Fig. 11), the mask stripe was 10 Fm for the active region and 4 Fm for the other regions (id. at 378, 2d col.).

The examiner's case for the obviousness of the subject matter of claim 22 is as follows (Answer at 3):

> Rolland teaches a Mach-Zehnder modulator structure including a thick width Y-portion and two thin width active region arms. The thick width portion is disclosed as 4 micron[s] wide. . . .
> Sasaki teaches on page 378 a mask stripe width of 10 micron[s] in the active region and 4 micron[s] in the other regions. Refer to Figure 11. On page 374 it is clearly taught that a wide mask (or narrow width modulator) results in thick MQW layers which results in

> decreased bandgap [energy].[6] It would have been obvious to a skilled artisan to apply the masking techniques for affecting bandgap as taught in Sasaki given that Rolland already teaches the claimed structure.

We agree with appellant that the examiner has confused the 2 Fm and 4 Fm widths of the MQW structures in Rolland's active and passive regions, respectively, with the thicknesses of the MQW structures in those regions, which Rolland does not disclose as being different. While Sasaki discloses using different mask widths to produce different MQW thicknesses and different band gap wavelengths in devices having active and passive regions with different bandgap energies, the examiner has not explained why the artisan would have been motivated by Sasaki to modify Rolland's modulator, which apparently has a uniform MQW thickness and bandgap wavelength, by forming the MQW structures in its active and passive portions with different thicknesses and thus different bandgap wavelengths, as required by claim 22. The § 103 rejection of claim 22 is therefore reversed, as is the rejection of dependent claims

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[6] As noted supra, this statement may refer to the 58.9 and 58.8 meV values given in Figure 4; as is apparent from that figure, this statement is incorrect if "bandgap energy" is understood to mean band gap wavelength.

23-26.

This decision contains a new ground of rejection pursuant to 37 CFR § 1.196(b)(amended effective Dec. 1, 1997, by final rule notice, 62 Fed. Reg. 53,131, 53,197 (Oct. 10, 1997), 1203 Off. Gaz. Pat. & Trademark Office 63, 122 (Oct. 21, 1997)). 37 CFR § 1.196(b) provides that, "A new ground of rejection shall not be considered final for purposes of judicial review."

37 CFR § 1.196(b) also provides that the appellant, WITHIN TWO MONTHS FROM THE DATE OF THE DECISION, must exercise one of the following two options with respect to the new ground of rejection to avoid termination of proceedings (§ 1.197(c)) as to the rejected claims:

> (1) Submit an appropriate amendment of the claims so rejected or a showing of facts relating to the claims so rejected, or both, and have the matter reconsidered by the examiner, in which event the application will be remanded to the examiner. . . .
>
> (2) Request that the application be reheard under § 1.197(b) by the Board of Patent Appeals and Interferences upon the same record. . . .

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136(a).

REVERSED: 37 CFR §196(b)

JOHN C. MARTIN Administrative Patent Judge	)	
LEE E. BARRETT Administrative Patent Judge	)	BOARD OF PATENT APPEALS AND INTERFERENCES
MICHAEL R. FLEMING Administrative Patent Judge	)	

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